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Deputy Chief, Engineering Branch

7 February 1950

Chief, Electronic Development Section

Feasibility of Miniature Gasoline Generator Set. CIA Project # OPC-29-50, "AWARD" Project.

The following report is submitted in compliance with your request of 3 February 1950, in regard to determining the feasibility of producing a miniature internal combustion engine generator set.

The study was divided into consideration of the thermal and mechanical efficiency, temperature rise, weight, and size and volume requirements.

I. THERMAL & MECHANICAL EFFICIENCY OF THE ENGINE

A. The design data of the 2 cycle engine was meager and assumptions will have to be made in order to evaluate the performance of the Unit. References that were consulted are:

1. Marks - "Mechanical Engineers' Handbook" 4th Edition
2. Streeter & Lichty - "Internal Combustion Engines"
3. Liston - "Aircraft Engine Design"
4. "SAE Handbook" 1949

The above literature supplied sufficient information on the theory of the 2 cycle engine to calculate the expected overall efficiency.

B. Engine Input (BTU)

Fuel - assume 100 octane ($C_8 H_{18}$)

H.H.V. = 21400 BTU/lb.

Engine Consumption = 14 oz. = $\frac{14}{16}$ lbs/hr.

Input energy = $\frac{14}{16}(21400) = 18720$ BTU/hr.

Input H.P. = $\frac{\text{BTU/min.}}{42.41} = \frac{18720}{60\ (42.41)} = 7.38$ H.P.

From Ref. 1, P. 1275, the thermal efficiency of this type of engine is given as 27.2%. From Ref. 1, P. 1266, a crank case compression power requirement of 7 to 12% (assume 10 %) is necessary. The mechanical efficiency of small engines seldom exceeds 80 % (assumed). Further serious power loss in this type of engine is due to incomplete combustion and lack of complete scavenging which may approach 50% of the input heat. (Ref. 2, P. 104). Further losses, of the order of 7% to 10%, are due to combustion time variation, temperature distribution in the cylinder, and extraneous heat losses.

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The indicated brake horsepower (ibh) is then equal to:

$$ibh = 7.32\ (.272)(.9)(.8)(.5)(.9) = .652\ H.P.$$

The above .652 H.P. is equivalent to 485 watts or 2150 ft. lbs. as compared to the specification's requirements of 200 watts and 884 ft. lbs.

C. The above demonstrates that sufficient output is available from the engine to operate the generator. Further analysis of heat loss indicates the necessity for including a blower fan for cooling.

II. TEMPERATURE RISE

A. The design of small engine driven equipment often entails serious problems in the elimination of waste heat without permitting temperature extremes. the following analysis is a breakdown of the expected heat dissapation:

Heat input to engine = 18720 BTU/hr.

Exhaust heat (27% thermal eff.) = 13280 BTU/hr.

Power developed (in terms of heat)

1. useful power output (100 watts/hr. = 341.3 BTU/hr.
2. crank case compression = 2460 BTU/hr.

Net heat to be dissipated = (input)-(exhaust)-(work)
= 18270 - 13280 -2801
= 2189 BTU/hr.

B. This 2189 BTU/hr. corresponds to a power dissipation of 643 watts. It is evident that when 643 watts must be eliminated from a box 6 x 6 x 9 inches some form of forced draft must be used. It is conceivable that the contractor is aware of this and may now be contemplating the use of a small fan or blower. The power to run the blower is available as determined from the study of the thermal and mechanical efficiency of the engine.

III. ESTIMATION OF WEIGHT

A. Component weight

Copper - wire for coils, etc. 8 coils @ 2 oz/coil	=	1.0
Steel		
Alnico VII - Field Magnets 8 (2-1/2 oz)	=	1.25
Pistons -(2 x 2 oz.)	=	.25
Cylinder -(2 x 6 oz.)	=	1.25
Aluminum Casting		
Crankcase	=	1.0
Alternator shell -about 1#	=	1.0

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